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ABSTRACT

Hammond's Cognitive Continuum theory posits that certain task features induce distinct processing modes (e.g., intuitive or analytic) and thus result in qualitatively different decision performance. Although the theory suggests the relation between task features and performance characteristics a priori, the validity of these predictions requires empirical verification. The main thrust of the present research was therefore to determine whether one such variable--display format--affects the way subjects process multiple predictive cues. Subjects were required to judge the suitability of hypothetical applicants for a clearly specified job based on information about each applicant's intelligence, motivation, skill, and experience. These predictive cues were displayed either as numerical cues or as positions on graphical scales. Using the policy capturing approach, an estimation of the subjects' weighting strategy under the numerical and graphical display conditions was obtained. Subjects' cue utilization (i.e., weighting of the four cues) was significantly affected by display format. Specifically, subjects tended to use all four cues when presented in graphic form, but only selected ones when displayed numerically. Implications of these findings are discussed within the framework of Hammond's Cognitive Continuum theory. (Author)

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The effect of information display format on decision strategies

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Abstract

Hammond's Cognitive Continuum theory posits that certain task features induce distinct processing modes (e.g, intuitive or analytic) and thus result in qualitatively different decision performance. Although the theory suggests the relation between task features and performance characteristics a priori, the validity of these predictions requires empirical verification. The main thrust of the present research was therefore to determine whether one such variable--display format--affects the way subjects process multiple predictive cues. Subjects were required to judge the suitability of hypothetical applicants for a clearly specified job based on information about each applicant's intelligence, motivation, skill, and experience. These predictive cues were diplayed either as numerical cues or as positions on grapnical scales. Using the policy capturing approach, an estimation of the subjects' weighting strategy under the numerical and graphical display conditions was obtained. Subjects' cue utilization (i.e., weighting of the four cues) was significantly affected by display format. Specifically, subjects tended to use all four cues when presented in graphic form, but only selected ones when displayed numerically. Implications of these findings are discussed within the framework of Hammond's Cognitive Continuum theory.

Current literature on human decision-making is rife with contradictions regarding whether or not human beings are capable of making normatively sound decisions -- some research suggests yes and other says no. One conclusion that has, however, emerged and that reconciles these contradictions is that the structure of the task or characteristics of the task are extremely important in determining the kind of decision behavior that is invoked. Thus some tasks might produce sensible decision behavior, while in others people can be shown to make embarrassing errors. For example, Tversky and Kahnemann or Bar-Hillel (1982) have shown that by making subtle variations in the wording of problems, subjects may or may not be shown to use base rates appropriately in making predictions. Of course, to claim that task features are important in influencing decision behavior and to stop at that doesn't provide much of a basis for understanding or predicting behavior, which is what we strive to do in psychology. It is necessary then to establish some framework within which we can try to understand which task features are important , and the exact ways in which they might affect decision behavior. Hammond has recently suggested a Cognitive Continuum theory that provides such a framework.

Hammond's theory posits that cognitive functioning can be described in terms of a continuum. The "intuitive" pole is at one end of this continuum and the "analytic" mode is at the other end. The middle points of the continuum represent different mixtures of the intuitive and analytic modes. This middle range is called "bounded rationality" or "common sense". The intuitive and analytic modes can be represented in terms of distinct performance characteristics. For example, the intuitive mode results in quick, inconsistent judgments in which the decision maker has low confidence; in contrast, the opposite is predicted for the analytic mode. According to

Hammond, tasks have different properties that vary in the form of cognition that they induce. So certain task characteristics induce intuition, others analysis and so on. Since intuition, analysis etc. result in distinct kinds of performance, by characterizing which task properties induce a certain form of cognition, predictions can be made regarding the observed performance.Thus, the theory specifies definite relationships between task properties and decision performance based on the mode of cognitive functioning that is likely to be invoked. For example, ambiguous stimuli for which the stimulus characteristics are not explicitly defined, say pictures, are likely to produce intuitive processing and thus result in quick, inconsistent judgments.

Hammond's theory has not yet been validated empirically. However, it has a certain appeal and hence served as a point of departure for the research that I am about to discuss here. The specific question we've been addressing is whether the format in which information is displayed produces qualitatively different decision performance. One basic approach involves manipulating display features in what is commonly referred to as a "policy capturing" paradigm. For those of you who are not familiar with what this paradigm is about, I will decribe it briefly now. The paradigm is used basically to determine how a subject combines and weights different pieces of information in tasks that involve prediction. Thus, the subject is typically required to make quantitative evaluations of a number of stimuli; the stimuli are decomposed and defined in terms of one or more cue dimensions. For example, a subject might be asked to predict success in graduate school for a set of students based on information about their GRE scores and GPA. The idea is to determine how information about the stimuli or the cues (viz., GRE and GPA) is used in making the prediction. In order to assess the extent to which the cues determine a

subject's predictions, his/her judgments are regressed on the cue values in a multiple regression analysis. Thus, multiple regression is used to model or "capture" each subject's method of combining and weighting information which is, in fact, his "policy" in making judgments. Note that a separate policy description is obtained for each subject.

To turn to our study, subjects judged the suitability of a set of job applicants based on four information cues -- intelligence, motivation, skill, and experience. The cue values were chosen such that each cue had a specified range, mean and standard deviation, and the cues were not intercorrelated. Thus, for example, values on intelligence had a mean of 25 and a standard deviation of 15, motivation had a mean of 5 and a standard deviation of 2, but these cues, intelligence and motivation, were not intercorrelated.

Two sets of applicant profiles (namely, information about the four cues) were presented to each subject: the cue values were displayed as numerical scores in one set (this was the numerical display condition) and as bar graphs in the other set (this was the graphical display condition). The illustrations of the two formats are shown in Figure 1. In the graphical format, the length of the bar indicated an applicant's score on a particular cue; although the scales were not numerically labeled, the highest possible value on that cue was indicated in relation to the bar. Subjects reviewed each applicant profile in a set and rated it on a suitability scale from 1 (extremely low) to 10 (extremely high). The two sets of profiles were rotated through the display conditions such that each set appeared in both numerical and graphical formats. Also, the format in which the information was displayed was counterbalanced such that half the subjects saw a numerical set of profiles followed by the graphical and the reverse was true for the other subjects.

For every subject, a separate policy equation was determined under the numerical and graphical formats by regressing the judgments on the cues. The raw score regression weights obtained for the four cues under each condition are an index of the weighting strategy used by a subject under that particular display format. Thus one way of determining the effect of display on decision strategies is to simply compare the regression weights using a repeated measures ANOVA. An ANOVA on these weights showed a significant effect of cue and a significant cue x format interaction (both effects were significant at the .001 level). The main effect of format was not significant. From our standpoint the interaction of cue x format was of greatest interest -- it indicates that subjects' cue utilization or weighting of the four cues is significantly affected by display format. The mean regression weights for the two formats are shown in Table 1.

One point that is worth noting is that the fourth cue, viz., experience, which received a negligible weight under the numerical format is given some consideration under the graphical format. Thus it appears that the graphical format leads the subjects to consider all four cues relative to the numerical format.

You might have noted that in this experiment the difference in weighting could have occurred because the scales on which the information was presented were not equivalent for the two types of display. In the numerical case the four cues were not equated with respect to scale and the cue values were presented as raw scores with different means and standard deviations. In the graphical case, all cues were represented on identical physical scales and had equivalent scale units. Thus, we replicated this experiment. The design of the second experiment was identical to the first one except that all cues had

the same means and SDs. Again, we found a significant difference in the weighting of four cues under the two formats. So there does appear to be something inherently different about the two formats that causes subjects to weight the same pieces of information differently.

How do these results fit into Hammond's Cognitive Continuum theory? There appears to be a tendency in the graphical display condition towards an equal weighting of the cues, a defined characteristic of intuitive processing in Hammond's framework. But at this juncture it is premature to claim that the numerical display produces more analysis than intuition whereas the opposite is true for the graphical display. Clearly, the two display conditions produced a reliable difference in the weighting of the same cues under the two formats. So it is obvious that subjects processed information differently under the two types of display. But it would be speculative to go beyond that conclusion. Also, we do not know whether the result would generalize to the strategies of expert decision-makers and that remains a question for future research.

Previous research that has used display as an independent variable has focused mainly on the speed and accuracy of the subjects' responses to some characteristics of the presented stimuli and usually there is an external criterion to evaluate the subjects' performance. There are virtually no studies that compare how display affects subjects' aggregation of information when there is no external accuracy measure. There is a considerable number of situations in the "real world" where the decision maker formulates his own rules to combine information from several sources and makes decisions. Hence our finding that format of displaying information influences subjects' weighting strategies is of considerable practical importance. It has

implications especially for design of computer based information processing systems.

Reference

Kahneman, D., Slovic, P., & Tversky, A. (Eds.). Judgment under uncertainty: Heuristics and biases. Cambridge University Press, 1982.

THE EFFECT OF INFORMATION DISPLAY FORMAT ON DECISION STRATEGIES

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I. ILLUSTRATION OF THE NUMERICAL AND GRAPHICAL DISPLAYS.

Numerical Display

Intelligence	26
Motivation	1
Skill	9
Experience	2

Graphical Display

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IQ      **************************                *
MOTIV   *****                                     *
SKILL   ******************                        *
EXP     ****                                      *
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